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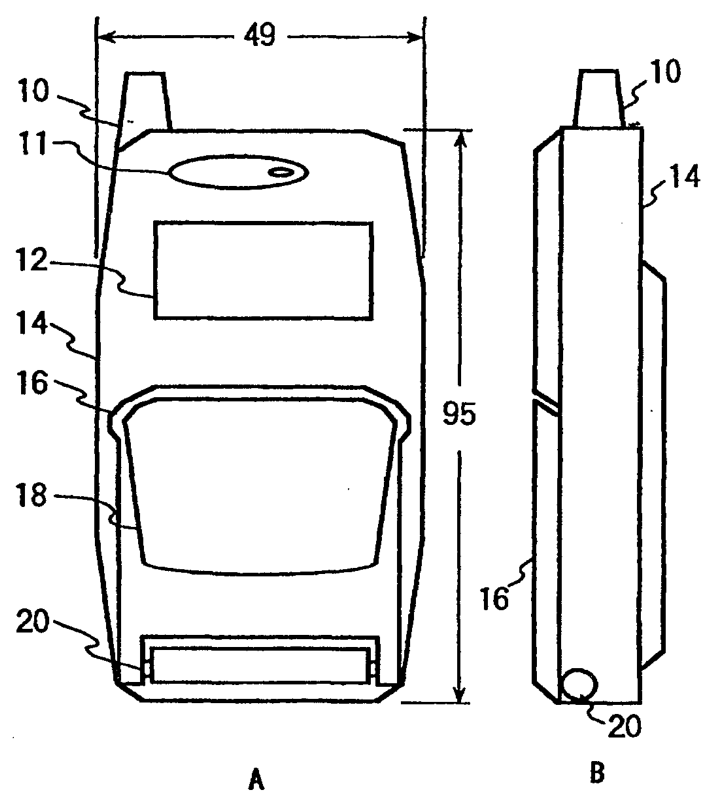
(57) Abstract

A cellular phone has a flip connected to the main body of the cellular phone in a pivotable manner. The flip has an inner face and an outer face when the flip is closed with respect to the main body. The main body has a first antenna, and the flip has a second antenna. The second antenna is preferably a plane antenna formed on the outer face of the flip by, for example, vacuum evaporation. The center of mass of the second antenna is located further from the main body than the center of the flip when the flip is opened. A coupling antenna is provided in the inner face of the flip, and a radio signal is transferred from the second antenna to the coupling antenna by capacitive coupling. A resonator element which resonates with the second antenna is also provided in the inner face of the flip in a region other than the area corresponding to the second antenna which is formed on the outer face of the flip. A receiving circuit for demodulating the radio signal, and a switch circuit for switching the inputs to the receiving circuit between the first and second antennas may also be provided to the cellular phone.



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CELLULAR PHONE, FLIP, AND HINGE

This patent application claims priority based on a Japanese patent application, H10-327890 filed on November 18, 1998, the contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to a wireless communication apparatus such as a cellular phone, a flip for such a wireless communication apparatus, and a hinge for connecting the flip to the main body of the wireless communication apparatus. In particular, the present invention relates to a cellular phone having an antenna in the flip.

2. Description of the Related Art

It has been proposed to provide a diversity antenna for exclusive use in signal receiving to a cellular phone, in addition to the main antenna attached to the main body of the cellular phone. In the conventional art, the diversity antenna is generally built into the main body of the cellular phone.

For example, Japanese Patent Application Laid-open No. 7-46014 discloses a cellular phone which has a second antenna fixed to the main body of the cellular phone, other than the whip antenna. Various antenna configurations and associated techniques are also disclosed in US patent Nos. 4,471,493, 4,939,792, 5,014,346, 5,073,761, 5,170,173, 5,337,061, 5,508,709, 5,554,996, 5,561,437, 5,572,223, and 5,579,023.

If a cellular phone is made compact in size, the distance

between the main antenna and the built-in diversity antenna decreases, and the effect of the space diversity is reduced. To overcome this problem, some cellular phones have their diversity antennas built into the flips. The flips generally have a metal part as an ornament or decoration. Such a metal part is formed by, for example, vacuum evaporation. The performance of the diversity antenna built in the flip is very sensitive to the properties of the metal part. In addition, the metal part of the flip also adversely affects the performance of the main antenna.

SUMMARY OF THE INVENTION

Therefore, it is an object of the present invention to overcome these drawbacks in the related art, and to provide a cellular phone which has a sufficient distance between the main antenna and the diversity antenna, to avoid deterioration of the performance of the main antenna. This object is achieved by combinations described in the independent claims. The dependent claims define further advantageous and exemplary combinations of the present invention.

In one aspect of the invention, a cellular phone which comprises a main body, a flip connected to the main body in a pivotable manner, a first antenna attached to the main body, a second antenna built into the flip, and a signal transfer unit for transferring a radio signal received by the second antenna to the main body, is provided. The flip is pivotable between an open position and a closed position where the flip is folded towards the main body of the cellular phone.

The flip has an inner face and an outer face in the state where the flip is closed toward the main body, and the second antenna is formed, for example, on the outer face of the flip. When the flip is opened, the center of mass of the second antenna

is located further from the main body than the center of the flip. The second antenna is, for example, a plane antenna. The second antenna is formed by, for example, vacuum evaporation , plating, or adhering a metal plate onto the flip. The flip may have a coupling antenna on the inner face, and the radio signal is transferred from the second antenna to the coupling antenna by capacitive coupling. In this case, the coupling antenna is formed on the inner face of the flip at a position corresponding to the second antenna formed on the outer face of the flip.

The coupling antenna is formed on the flip by, for example, by vacuum evaporation , plating, or adhering a metal plate onto the flip. The flip may have a resonator element which resonates with the second antenna. In this case, the signal transfer unit has one or more hinges for connecting the flip to the main body of the cellular phone in a pivotable manner. Each hinge comprises a shaft and a transmission line for connecting the resonator element to the ground of the main body of the cellular phone. The resonator element is provided to, for example, the inner face of the flip, and preferably, the resonator element is provided to the inner face of the flip in an area other than the region corresponding to the second antenna formed on the outer face of the flip.

If the signal transfer unit has one or more hinges for connecting the flip to the main body of the cellular phone in a pivotable manner, each hinge preferably has a shaft so that the radio signal is transferred from the second antenna to the main body of the cellular phone via the shaft of each hinge. In this case, the hinge has a pipe surrounding the shaft, and the radio signal is transferred from the second antenna to the main body via the shaft and the pipe of the hinge, based on the capacitive coupling between the shaft and the pipe. Each hinge may further have a brush which is rotatable about the shaft. In this

configuration, the flip preferably has a microphone, and a combiner for combining the outputs from the second antenna and the microphone into a single signal line. The single signal line is transferred to the main body of the cellular phone via the shaft and the brush of the hinge.

Preferably, the combiner has a first coil inserted in series between the microphone and the shaft, a second coil inserted in series between the microphone and the reference voltage of the cellular phone. The cellular phone may further comprise a receiving circuit for demodulating the radio signal, and a switch circuit for switching over the input to the receiving circuit between first and second antennas so as to allow only one of the radio signals received at the first and second antennas to be supplied to the receiving circuit.

Preferably, the cellular phone has a field-strength meter for measuring the intensity of the electric field of the received signal. It is determined if the flip is closed or opened based on the detected intensity of the electric field. In this case, the cellular phone changes into the off-hook state if the intensity detector detects a predetermined level of electric field. The cellular phone may further comprise an LCD display and a back light for the LCD display. The back light is turned on if the intensity detector detects a predetermined level of electric field.

In another aspect of the invention, a hinge for connecting a first object to a second object in a pivotable manner is provided. This hinge comprises a shaft connected to the first object, and a pipe surrounding the shaft so as to be rotatable about the shaft, the pipe being connected to the second object. An alternating signal is transferred between the shaft and the pipe by capacitive coupling generated between the shaft and the pipe. The hinge

comprises a shaft connected to the first object, and a connector connected to the second object, which contacts with the shaft in such a way as to allow a sliding movement.

In still another aspect of the invention, a flip is provided. The flip comprises a connector for connecting the flip to a main body of a cellular phone in a pivotable manner, a metal plate, and a signal line connected to the metal plate and extending to the connector. The flip has an inner face and an outer face in the state where the flip is closed toward the main body of the cellular phone, and a metal plate is provided on the outer face of the flip. Preferably, the center of mass of the metal plate is located further from the connector than the center of the flip.

The metal plate is formed directly onto the flip by vacuum evaporation or plating, or by adhering a separate metal plate onto the flip. Preferably, the flip further comprises a coupling metal plate on its inner face, and a radio signal is transferred from the metal plate to the coupling metal plate by capacitive coupling. The flip also comprises a resonator element that resonates with the metal plate. In this case, the resonator element is preferably provided to the inner face of the flip.

The resonator element is provided, for example, in an area other than the region corresponding to the metal plate provided onto the outer face of the flip. The flip may have a microphone, and a combiner for combining the outputs from the metal plate and the microphone into a single signal line. In this case, the combiner has a first coil inserted in series between the microphone and the shaft of the connector, a second coil inserted in series between the microphone and the reference voltage of the cellular phone.

This summary of the invention does not necessarily describe

all essential features. The invention may also be a sub-combination of these described features.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects and features of the invention will become more apparent from the following detailed description of the preferred embodiments with reference to the attached drawings, wherein:

Fig. 1 illustrates the cellular phone according to an embodiment of the invention. Fig. 1A is a front view, and Fig. 1B is a side view of the cellular phone;

Fig. 2 illustrates the flip of the cellular phone shown in Fig. 1;

Fig 3 schematically illustrates an example of the antenna circuit of the flip shown in Fig. 2;

Fig. 4 illustrates another example of the antenna circuit of the flip;

Fig. 5 illustrates the hinge of the cellular phone shown in Fig. 1;

Fig. 6 illustrates a modification of the hinge shown in Fig. 5;

Fig. 7 is a block diagram of the cellular phone shown in Fig. 1;

Fig. 8 is a circuit diagram showing the signal composition unit, the microphone filter, and the peripheral circuit thereof;

Fig. 9 illustrates the directivity of the antenna within a horizontal plane of the cellular phone shown in Fig. 1;

Fig. 10 illustrates the directivity of the antenna within the first vertical plane of the cellular phone shown in Fig. 1;

Fig. 11 illustrates the directivity of the antenna within the second vertical plane of the cellular phone shown in Fig. 1; and

Fig. 12 illustrates the directivity of the antenna measured with the flip shown in Fig. 11 closed.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention will now be described based on the preferred embodiments, which do not intend to limit the invention, but exemplify the invention. All of the features and the combinations thereof described in the embodiment are not necessarily essential to the invention.

Fig. 1 illustrates a cellular phone according to an embodiment of the invention. Fig. 1A is a front view, and Fig. 1B is a side view of the cellular phone. The cellular phone has a main body 14, a flip 16, and a hinge 20 which connects the flip 16 to the main body 14 in a pivotable manner. The main body 14 has a first antenna 10, a speaker 11, and an LCD 12. When the flip 16 is closed toward the main body, it has an inner face and an outer face. A plane antenna (i.e., a second antenna) 18 is formed on the outer face of the flip 16 by vacuum evaporation or plating. The second antenna 18 may function as an ornament of the flip. As an alternative, the second antenna may be formed by adhering a metal plate having a predetermined size and shape

onto the flip. Since the first antenna 10 is provided to the main body 14, a sufficient distance can be provided between the first and second antennas when the flip 16 is open. Thus, even if the cellular phone itself is compact in size, a sufficient diversity gain can be obtained based on the positional effect.

Fig. 2 illustrates the flip 16 with specific dimensions. The width of the flip 16 is approximately 41mm and the length is approximately 42mm. The second antenna 18 is formed on the flip 18 by, for example, vacuum evaporation. In order to increase the radiation efficiency of the antenna, the width of the second antenna 18 is preferably 80% or more of the width of the flip 16. The length of the second antenna 18 is preferably 50% or more of the length of the flip 16.

The center of mass of the second antenna 18 is located further from the hinge 20 than the center point of the flip 16. Accordingly, when the flip 16 is open, the center of mass of the second antenna 18 is further from the main body 14 than the center point of the flip 16. This arrangement allows the radio wave to easily resonate between the main body 14 and the second antenna 18, and at the same time, the space diversity effect can be enhanced when a radio signal is received by the first and second antenna 10 and 18 with a diversity reception technique.

Fig. 3 illustrates the inner face (or the rear face) of the flip 16, and in particular, Fig. 3B shows the electrical connection of the flip 16. The hinge 20 functions as a connector between the flip 16 and the main body 14. The second antenna 18, which is indicated by the dashed lines in Fig. 3, is connected to the hinge 20 via a signal line. The flip 16 has a microphone 22, and the output from the microphone 22 is combined with the output from the second antenna 18 in the flip 16.

The rear face (or the inner face) of the flip 16 is provided with a resonator element which resonates with the antenna 18. Because the dimensions of the antenna 18, which is formed on the outer face of the flip 16, are not freely changeable for reasons of design, the dimensions of the resonator element 24, as well as its radiation impedance and radiation pattern, are adjusted in order to obtain the optimal radiation efficiency and receiving efficiency at a desired frequency band.

It is preferable for the resonator element 24 and the antenna 18 to be separated as much as possible. To decrease the capacitive coupling between the resonator element 24 and the antenna 18, the resonator element 24 is preferably located at a position other than a position corresponding to the second antenna formed on the outer face of the flip 16.

Fig. 4 illustrates another example of the configuration of the flip 16. In the example shown in Fig. 3, the antenna 18 is connected to the main body 14 of the cellular phone by a signal line that is soldered directly to the antenna 18. However, if the signal line is soldered directly to the antenna 18, the outer surface of the flip is likely to be uneven at the signal-connection areas due to the connection terminals. To eliminate the unevenness, a coupling antenna 26 is provided to the inner face of the flip 16 in the example shown in Fig. 4. The coupling antenna 26 is positioned in the region corresponding to the antenna 18 on the outer face, and the signal line is connected to the coupling antenna 26, in order that the unevenness on the outer surface can be avoided.

In this case, the radio signal is transferred from the antenna 18 to the coupling antenna 26 by capacitive coupling, and is further transferred to the signal line. The coupling antenna is formed on the flip by at least one method of vacuum evaporation,

plating, and adhering a metal plane on to the flip.

Fig. 5 illustrates the hinge 20 shown in Fig. 1. One or more hinges 20 are attached between the flip 16 and the main body 14 of the cellular phone. Each hinge 20 connects the flip 16 to the main body 14 in a pivotable manner. The hinge 20 has a first signal line 40, which is connected to the antenna 18, and a second signal line (or a ground cable) 42, which is connected to the resonator element 24. The hinge 20 also has a shaft 34, to which the first signal line 40 is connected, and a brush 44 which is in contact with the shaft 34 in such a way to allow sliding movement of the brush 44.

The second signal line 42 is connected to a hinge element 36 surrounding the shaft 34. The hinge element 36 is in contact with the second hinge element 38 in such a way to allow sliding movement. On the side of the main body 14, the ground cable (i.e., the second signal line) 46 is connected to the second hinge element 38, and the brush 44 is connected to the receiving circuit of the main body 14. Accordingly, both the antenna 18 and the resonator element 24 are connected to the main body 14 by a single hinge 20.

As an alternative, the antenna 18 may be connected to the main body 14 by the hinge elements 36 and 38, while the resonator element 24 is connected to the main body 14 via the shaft 34. As another modification, the antenna 18 may be connected to the main body 14 by the shaft 34 of one hinge 20, and the resonator element 24 may be connected to the main body 14 by the shaft 34 of another hinge 20. As still another alternative, the antenna 18 may be connected to the main body 14 by the hinge elements 36 and 38 of one hinge 20, while the resonator element 24 may be connected to the main body 14 by the hinge elements 36 and 38 of another hinge 20. As yet another alternative, the antenna 18 may be connected

to the brush 44, and the receiving circuit of the main body 14 may be connected to the shaft 34, with which the brush 44 contacts in a manner that permits a sliding movement.

Fig. 6 illustrates a hinge 20 according to another embodiment of the invention. The hinge 20 of this embodiment has a pipe 32 surrounding the shaft 34, in addition to the elements shown in Fig. 5. The signal line 48 of the main body 14 is connected to the pipe 32, instead of being connected to the shaft 34. The pipe 32 is rotatable about the shaft 34, and a radio signal is transferred from the shaft 34 to the pipe 32 by capacitive coupling generated between the shaft 34 and the pipe 32.

In this embodiment, a radio signal is transferred from the antenna 18 to the main body 14 via a transmission line having an impedance of 50Ω. In a frequency band from 800MHz to 1000MHz, for example, capacitive coupling of approximately 100pF between the shaft 34 and the pipe 32 is sufficient. By adjusting the length of the pipe 32, the capacitive coupling can be appropriately varied even if the frequency of the radio signal changes. Thus, optimum capacitance is easily generated for a desired frequency.

However, since the frequency of the signal from the microphone 22 is low, it is difficult to transfer the microphone signal to the main body 14 via the shaft 34. Therefore, a separate signal line is added for the purpose of transferring the microphone signal in this embodiment, or alternatively, at least one of the two hinges 20 is designed as shown in Fig. 5, and the antenna signal is transferred to the main body 14 via the shaft 34 of the hinge 20.

Fig. 7 is a block diagram of the circuit of the cellular phone shown in Fig. 1. A controller 60 controls the overall operations

of the cellular phone. A receiving circuit 80 demodulates a radio signal, and supplies the demodulated radio signal to the controller 60. A switch circuit 50 switches the inputs from the first and second antennas 10 and 18 so as to supply only one of the radio signals received by these two antennas to the receiving circuit 80. A transmission circuit 72 modulates the transmission signal output from the controller 60. A synthesizer 70 supplies signals for demodulation and modulation to the receiving circuit 80 and the transmission circuit 72, respectively.

A back light 74 illuminates the LCD 12 based on a control signal supplied from the controller 60. A vibrator 62 informs the user of a call received by the cellular phone. The user can operate the cellular phone through a key pad 64. An amplifier 66 amplifies a voice signal output from the controller 60, and the amplified voice signal is output from a speaker 11. The flip 16 has a combiner 28 which combines the output from the microphone 22 and the output from the antenna 18 into a single signal line. The signal line extends from the combiner 28 to the main body 14.

The receiving circuit 80 comprises a capacitor 52 for blocking a direct current, a radio frequency amplifier 54 for amplifying the received signal, a mixer 56 for demodulating the amplified signal, an intermediate frequency amplifier 58 for amplifying the demodulated signal again, a field-strength meter (RSSI) 76 for measuring the intensity of the electric field of the received signal, and a mike filter 68 for extracting a signal component of a voice frequency band from the received signal. If the field-strength meter 76 detects a predetermined intensity of electric field, the controller 60 determines that the flip 16 is opened. If the field-strength meter 76 detects another predetermined level of electric field while the cellular phone is receiving a call, the controller 60 changes the cellular phone to the off-hook state. If the field-strength meter 76 detects

the said predetermined level of electric field without any external calls, the controller 60 determines that a call-out action is to be taken, and causes the back light 74 for the LCD 12 to be turned on.

The predetermined value used to determine the opening of the flip 16 is, for example, the maximum receiving intensity with the flip 16 closed plus a margin. Alternatively, the intensity of the received electric field is continuously monitored by the field-strength meter 76, and if the direct-current voltage output from the field-strength meter 76 abruptly increases, it is determined that the flip 16 has been opened. The opening of the flip 16 may be determined based on both an abrupt increase in the intensity of the detected field, and the exceeding of the predetermined threshold value. With either method, the opening of the flip 16 can be detected without using a mechanical switch. This allows the cellular phone to be made compact in size at a low cost, while the probability of failure or breakdown can be decreased.

Fig. 8 is a circuit diagram of the combiner 28, the mike filter 68, and other peripheral elements shown in Fig. 7. The combiner 28 has a coil L1 inserted in series between the microphone 22 and the signal line of the antenna 18, and a coil L2 inserted in series between the reference voltage (such as a ground voltage of the cellular phone) and the microphone 22. The combiner 28 also has a capacitor C3 of 47pF for connecting the microphone-side terminals of the coils L1 and L2 in parallel, and a capacitor C1 inserted on the line of the antenna 18 on the input side of the combiner 28. Because the combiner 28 blocks the radio frequency component between the microphone 22 and the antenna 18, this arrangement can prevent the performance of the antenna 18 from deteriorating due to the microphone 22.

The mike filter 68 has a coil L3 inserted in series in the signal line of the antenna 18, a resistor R of 2.2KΩ inserted in series between the output of the coil L3 and the power source of the microphone, a capacitor C4 of 3.3μF inserted in series between the output of the coil L3 and the output of the microphone 22, and a capacitor C2 inserted on the line of the antenna 18 at a position closer to the main body than the connection point of the mike filter 68. The direct-current voltage supplied from the power source of the microphone is blocked by the capacitors C1 and C2, and then supplied to the microphone 22 via the coils L1 and L3.

The mike signal generated by the microphone 22 is superimposed on the signal received from the antenna 18. Accordingly, the number of signal lines between the flip 16 and the main body 14 can be reduced. The mike filter 68 allows only the signal component of the voice frequency band to be extracted as a mike signal at the output terminal of the capacitor C4. In addition, because the mike filter 68 blocks the radio frequency component at the coil L3 positioned between the mike output and the antenna output, mutual influence of the antenna output and the mike output, that is, deterioration of the antenna performance due to the mike output, and deterioration of the mike output due to the antenna output, can be prevented.

It is desirable that the capacitance of the capacitors C1 and C2 is set so as not to affect the impedance and attenuation of the signal at the receiving band. For this reason, the capacitance of C1 and C2 is set to 100pF in this embodiment. The inductance of the coils L1 through L3 is set to a constant value that does not affect the mike signal, the impedance, or the attenuation of the signal significantly, and it is set to 100nH in this embodiment. The coils L1 through L3 can prevent the radio frequency component of the antenna signal from flowing into the

signal path to the microphone 22. In particular, the coil L2 inserted between the microphone 22 and the ground can effectively prevent the radio signal component superimposed on the ground from flowing into the microphone side.

<Examples>

Fig. 9A, 10A, and 11A are the top views of the cellular phone set in various postures, and Figs. 9B, 10B, and 11B are the diagrams showing the antenna directivities of the cellular phone shown in Figs. 1 and 2 at the corresponding postures. The frequency was set to 885MHz, and the standard antenna level was set to -45.1dBm in all measurements. In Fig. 9, the cellular phone was stood vertically (as shown in Fig. 9A), and its directivity was measured for 360 degrees around the cellular phone. In Fig. 10, the cellular phone was laid horizontally (as shown in Fig. 10A), and the directivity of the cellular phone was measured in a plane covering the left, right, above and below. In Fig. 11, the cellular phone was placed sideways (as shown in Fig. 11A), and the directivity was measured in a plane covering the front, back, above and below.

The following is the data obtained by the measurement.

1. Within a horizontal plane (Fig. 9)

Antenna Gain: -0.4dBd

Average Gain: -2.5dBd

angle	relative level (dB)	angle	relative level (dB)
0	-0.77	180	-5.31
10	-0.62	190	-5.43
20	-0.45	200	-5.44
30	-0.37	210	-5.30
40	-0.35	220	-4.97

50	-0.37	230	-4.61
60	-0.44	240	-4.18
70	-0.59	250	-3.74
80	-0.81	260	-3.30
90	-1.08	270	-2.92
100	-1.45	280	-2.52
110	-2.03	290	-2.20
120	-2.73	300	-1.88
130	-3.21	310	-1.66
140	-3.74	320	-1.40
150	-4.24	330	-1.17
160	-4.67	340	-1.02
170	-5.02	350	-0.87

2. Within a vertical plane (Fig. 10)

Antenna Gain: -1.3dBd

Average Gain: -6.9dBd

angle	relative level (dB)	angle	relative level (dB)
0	-1.31	180	-3.77
10	-1.47	190	-4.19
20	-1.89	200	-5.15
30	-2.65	210	-6.17
40	-3.78	220	-7.55
50	-5.25	230	-9.40
60	-7.06	240	-11.80
70	-9.27	250	-14.42
80	-11.77	260	-16.36
90	-13.01	270	-15.00
100	-11.77	280	-12.08
110	-9.89	290	-9.29
120	-8.11	300	-6.62
130	-6.57	310	-4.70
140	-5.51	320	-3.26

150	-4.63	330	-2.26
160	-4.05	340	-1.62
170	-3.78	350	-1.38

As is exhibited by the above-listed measurement data and the graphs shown in Figs. 9 to Fig.11, the directivity of the antenna according to the invention is uniform in a horizontal plane, and the directivity is broad in a vertical plane.

Fig. 12 shows the directivity of the antenna measured with the cellular phone placed sideways, as in Fig. 11, and with the flip closed. As compared with Fig. 11, the gain decreases in all directions because the flip is closed. Since the intensity of the electric field changes each time the flip is closed or opened, the opening and closing of the flip can be detected based on the detected intensity of the electric field.

As has been described, a cellular phone and a flip with an antenna, which is suitable for the cellular phone, are provided.

Although the present invention has been described by way of exemplary embodiments, it should be understood that many changes and substitutions may be made by those skilled in the art without departing from the spirit and the scope of the invention which is defined only by the appended claims.

For example, this invention can also be applied to a portable computer having a flip, or other similar products. Such products are also included in the technical scope of the present invention.

WHAT IS CLAIMED IS:

1. A cellular phone comprising:

a main body;

a flip connected to the main body in a pivotable manner between an open position and a closed position;

a first antenna attached to the main body;

a second antenna built in the flip; and

a signal transfer unit for transferring a radio signal received by the second antenna to the main body.

2. The cellular phone according to claim 1, wherein the flip has an inner face and an outer face in a state where the flip is closed toward the main body, and the second antenna is formed on an outer face of the flip.

3. The cellular phone according to claim 1, wherein when the flip is opened, a mass center of the second antenna is located further from the main body than a center of the flip.

4. The cellular phone according to claim 1, wherein the second antenna is a plane antenna.

5. The cellular phone according to claim 1, wherein the second antenna is formed on the flip by at least one method of vacuum evaporation, plating, and adhering a metal plate onto the flip.

6. The cellular phone according to claim 1, wherein the flip has a coupling antenna on an inner face of the flip, and the radio signal is transferred from the second antenna to the coupling antenna by capacitive coupling.

7. The cellular phone according to claim 6, wherein the coupling antenna is formed on the inner face of the flip at a position

corresponding to the second antenna formed on an outer face of the flip.

8. The cellular phone according to claim 6, wherein the coupling antenna is formed on the flip by at least one method of vacuum evaporation, plating, and adhering a metal plane onto the flip.

9. The cellular phone according to claim 1, wherein the flip has a resonator element which resonates with the second antenna.

10. The cellular phone according to claim 9, wherein the signal transfer unit has one or more hinges for connecting the flip to the main body of the cellular phone in a pivotable manner, each hinge comprising a shaft for transmitting a radio signal from the second antenna to the main body and a transmission line for connecting the resonator element to a ground of the main body of the cellular phone.

11. The cellular phone according to claim 9, wherein the resonator element is provided to an inner face of the flip.

12. The cellular phone according to claim 11, wherein the resonator element is provided to the inner face of the flip in a area other than a region corresponding to the second antenna formed on an outer face of the flip.

13. The cellular phone according to claim 1, wherein the signal transfer unit has one or more hinges for connecting the flip to the main body of the cellular phone in a pivotable manner, each hinge having a shaft, and wherein the radio signal is transferred from the second antenna to the main body of the cellular phone via the shaft of each hinge.

14. The cellular phone according to claim 13, wherein each hinge

has a pipe surrounding the shaft, and the radio signal is transferred from the second antenna to the main body via the shaft and the pipe of the hinge based on a capacitive coupling between the shaft and the pipe.

15. The cellular phone according to claim 13, wherein each hinge has a brush which is rotatable about the shaft.

16. The cellular phone according to claim 15, wherein the flip has a microphone and a combiner for combining outputs from the second antenna and the microphone into a single signal line, wherein the single signal line is transferred to the main body of the cellular phone via the shaft and the brush of the hinge.

17. The cellular phone according to claim 16, wherein the combiner has a first coil inserted in series between the microphone and the shaft, a second coil inserted in series between the microphone and a reference voltage of the cellular phone.

18. The cellular phone according to claim 1, further comprising a receiving circuit for demodulating the radio signal, and a switch circuit for switching an input to the receiving circuit between the first and second antennas so as to allow only one of the radio signals received at the first and second antennas to be supplied to the receiving circuit.

19. The cellular phone according to claim 1, further comprising an intensity detector for measuring an intensity of an electric field of a signal received by the second antenna, and it is determined if the flip is closed or opened based on the measured intensity of the electric field.

20. The cellular phone according to claim 19, wherein the cellular phone changes to a off-hook state if the intensity

detector detects a predetermined level of electric field while receiving a call.

21. The cellular phone according to claim 19, further comprising an LCD display and a back light for the LCD display, wherein the back light is turned on if the intensity detector detects a predetermined level of an electric field.

22. A hinge for connecting a first object to a second object in a pivotable manner, the hinge comprising:

a shaft connected to the first object; and

a pipe surrounding the shaft so as to be rotatable about the shaft, the pipe being connected to the second object, wherein an alternating signal is transferred between the shaft and the pipe by capacitive coupling generated between the shaft and the pipe.

23. A hinge for connecting a first object to a second object in a pivotable manner, the hinge comprising:

a shaft connected to the first object; and

a connector connected to the second object, wherein the connector contacts with the shaft in such a way as to allow a sliding movement.

24. A flip comprising:

a connector for connecting the flip to a main body of a cellular phone in a pivotable manner;

a metal plate; and

a signal line connected to the metal plate and extending to the connector.

25. The flip according to claim 24, wherein the flip has an inner face and an outer face in a state where the flip is closed toward the main body of the cellular phone, and the metal plate is provided

onto the outer face of the flip.

26. The flip according to claim 24, wherein a mass center of the metal plate is located further from the connector than a center of the flip.

27. The flip according to claim 24, wherein the metal plate is formed directly onto the flip by at least one method of vacuum evaporation, plating, and by adhering a separate metal plate onto the flip.

28. The flip according to claim 24, further comprising a coupling metal plate on its inner face, and a radio signal is transferred from the metal plate to the coupling metal plate by capacitive coupling.

29. The flip according to claim 24, further comprising a resonator element which resonates with the metal plate.

30. The flip according to claim 29, wherein the resonator element is provided to an inner face of the flip.

31. The flip according to claim 30, wherein the resonator element is provided to the inner face of the flip in an area other than a region corresponding to the metal plate provided on an outer face of the flip.

32. The flip according to claim 24, further comprising a microphone, and a combiner for combining outputs from the metal plate and the microphone into a single signal line.

33. The flip according to claim 32, wherein the connector has a shaft, and wherein the combiner has a first coil inserted in series between the microphone and a shaft, a second coil inserted

in series between the microphone and a reference voltage of the cellular phone.

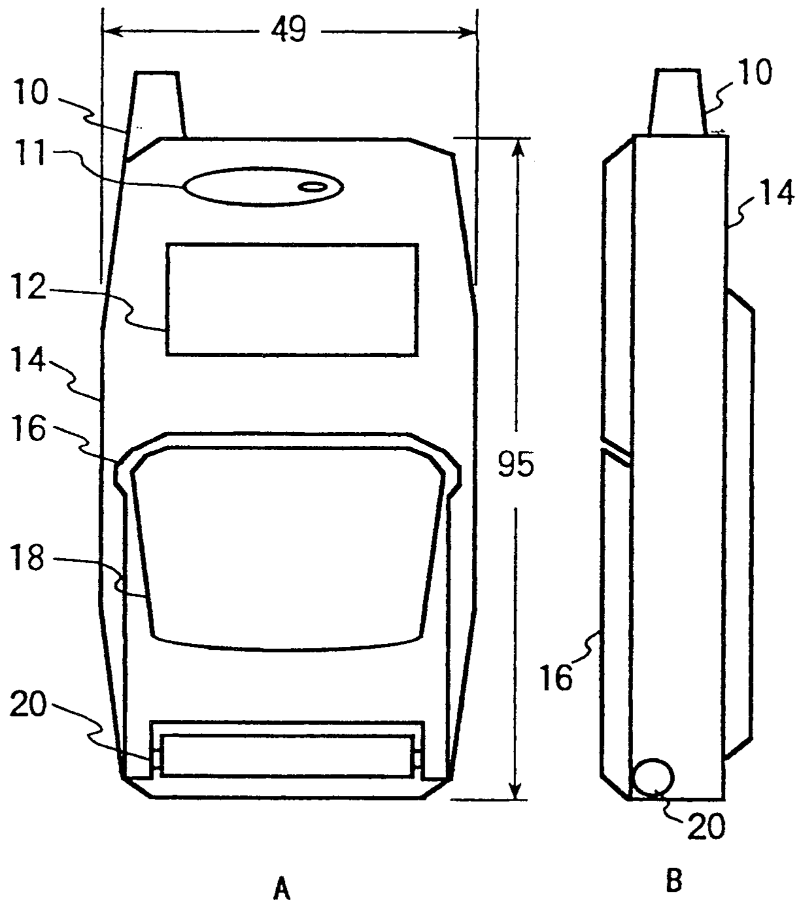


FIG. 1

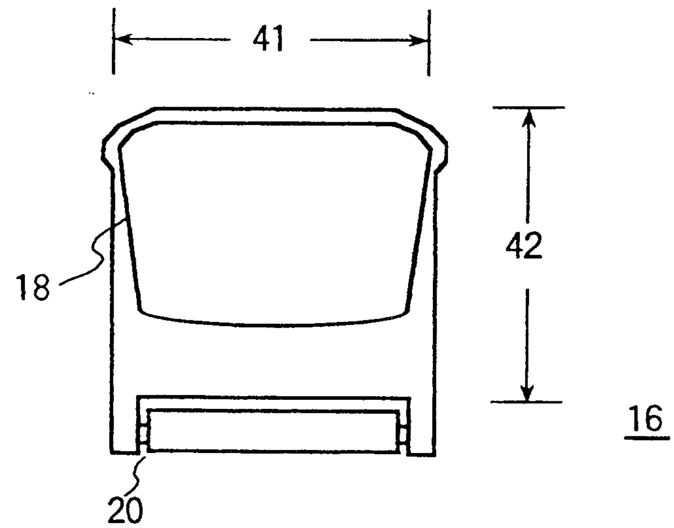


FIG. 2

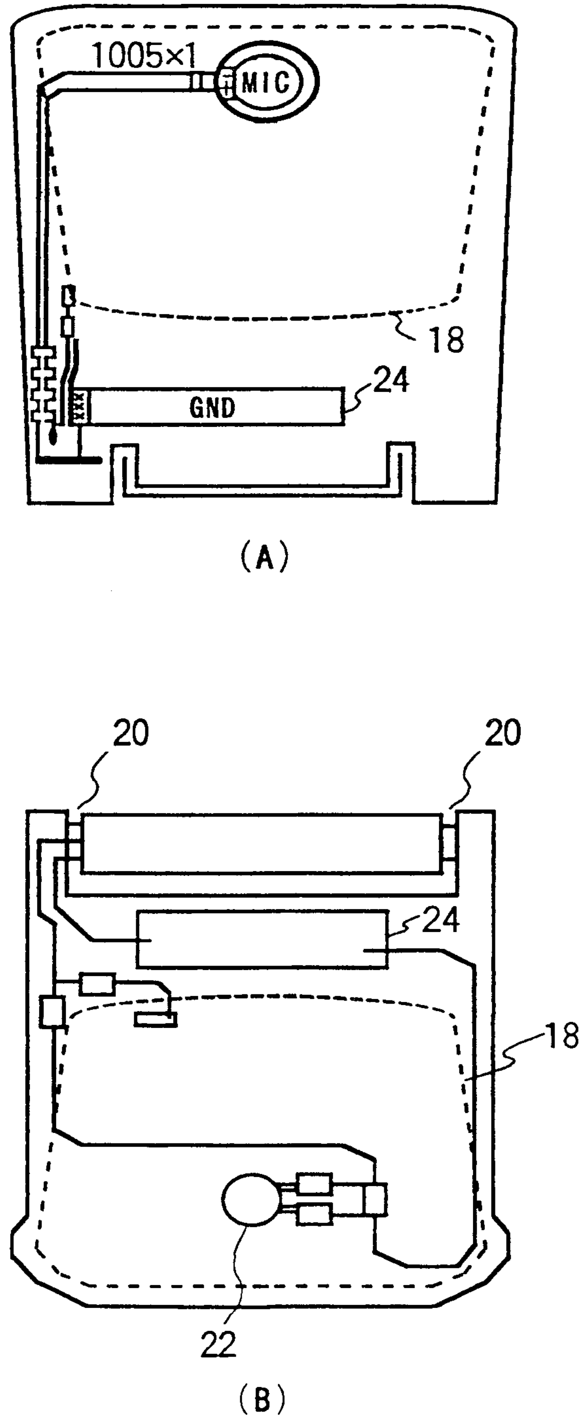
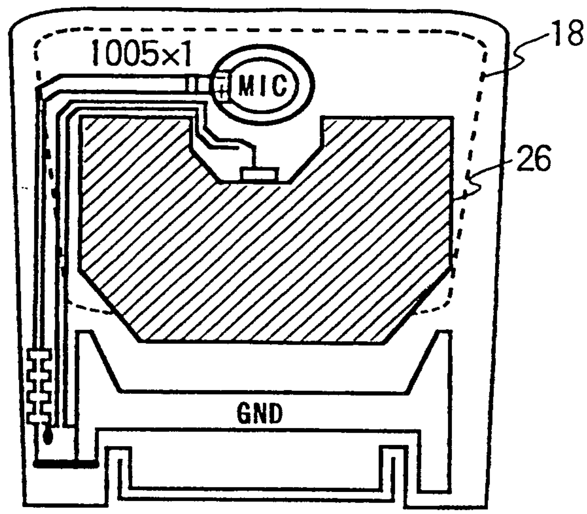


FIG. 3



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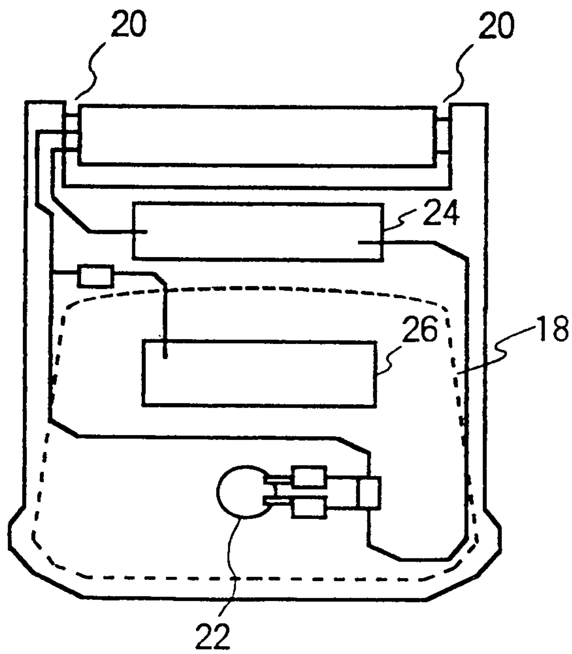


(B)

FIG. 4

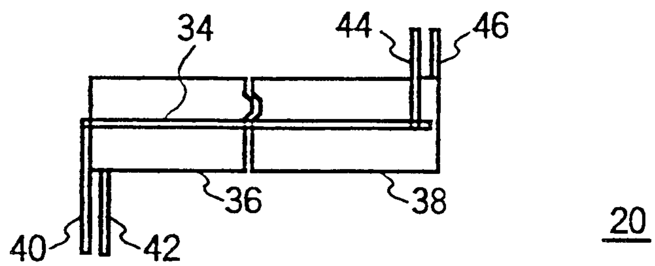


FIG. 5

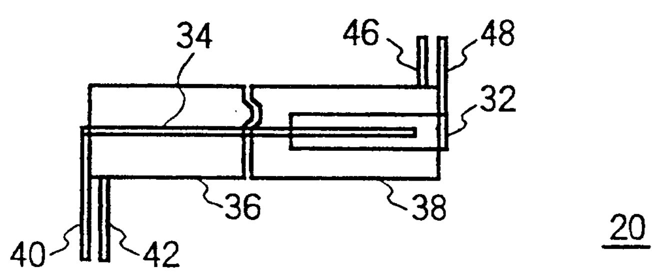


FIG. 6

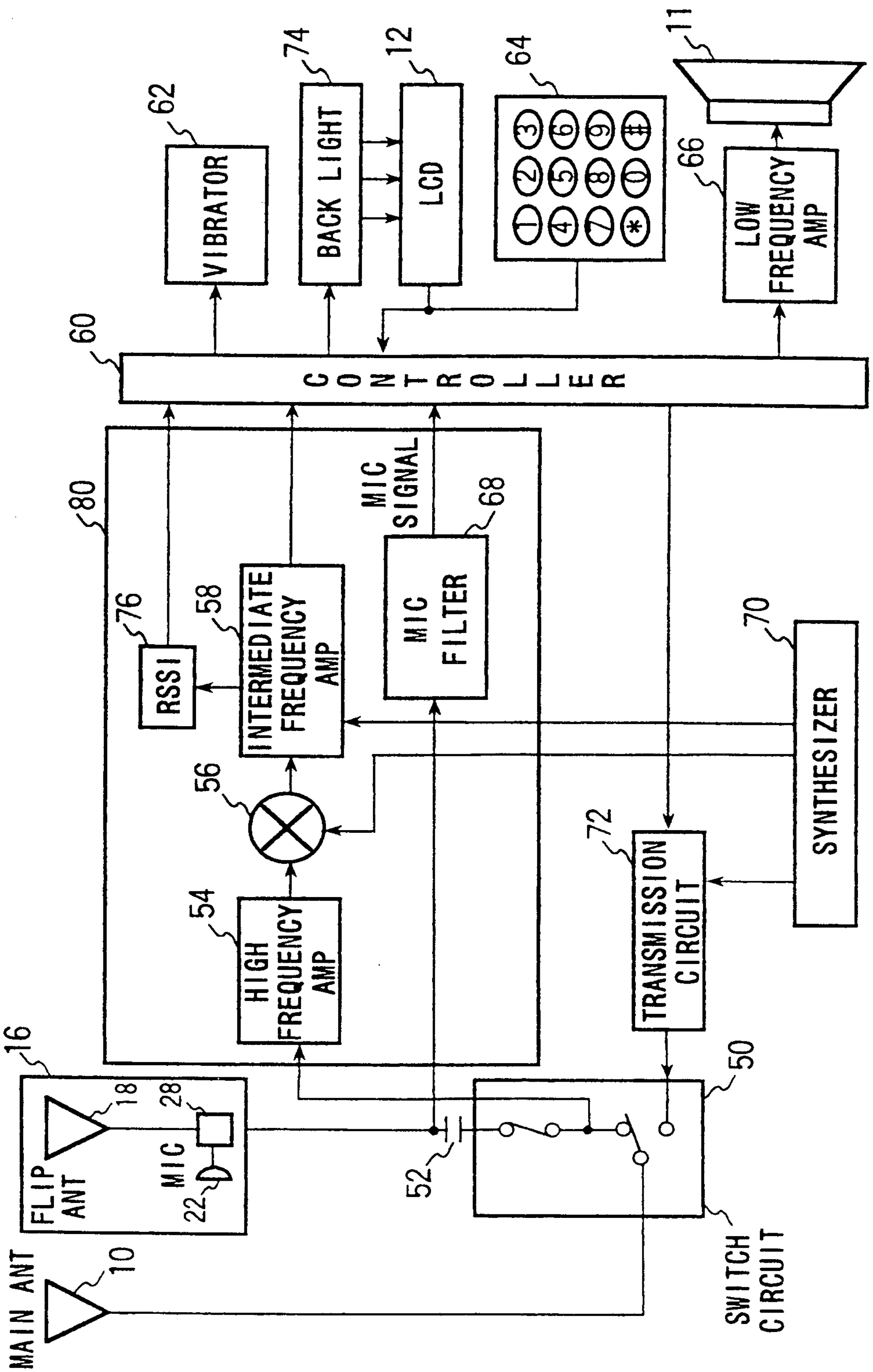

VIBRATOR
BACK LIGHT
LCD
LOW FREQUENCY AMP
CONTROLLER
MIC SIGNAL
RSSI
INTERMEDIATE FREQUENCY AMP
MIC FILTER
HIGH FREQUENCY AMP
TRANSMISSION CIRCUIT
SYNTHESIZER
FLIP ANT
MIC
MAIN ANT
SWITCH CIRCUIT
10
11
12
16
18
22
28
50
52
54
56
58
60
62
64
66
68
70
72
74
76
80

FIG. 7

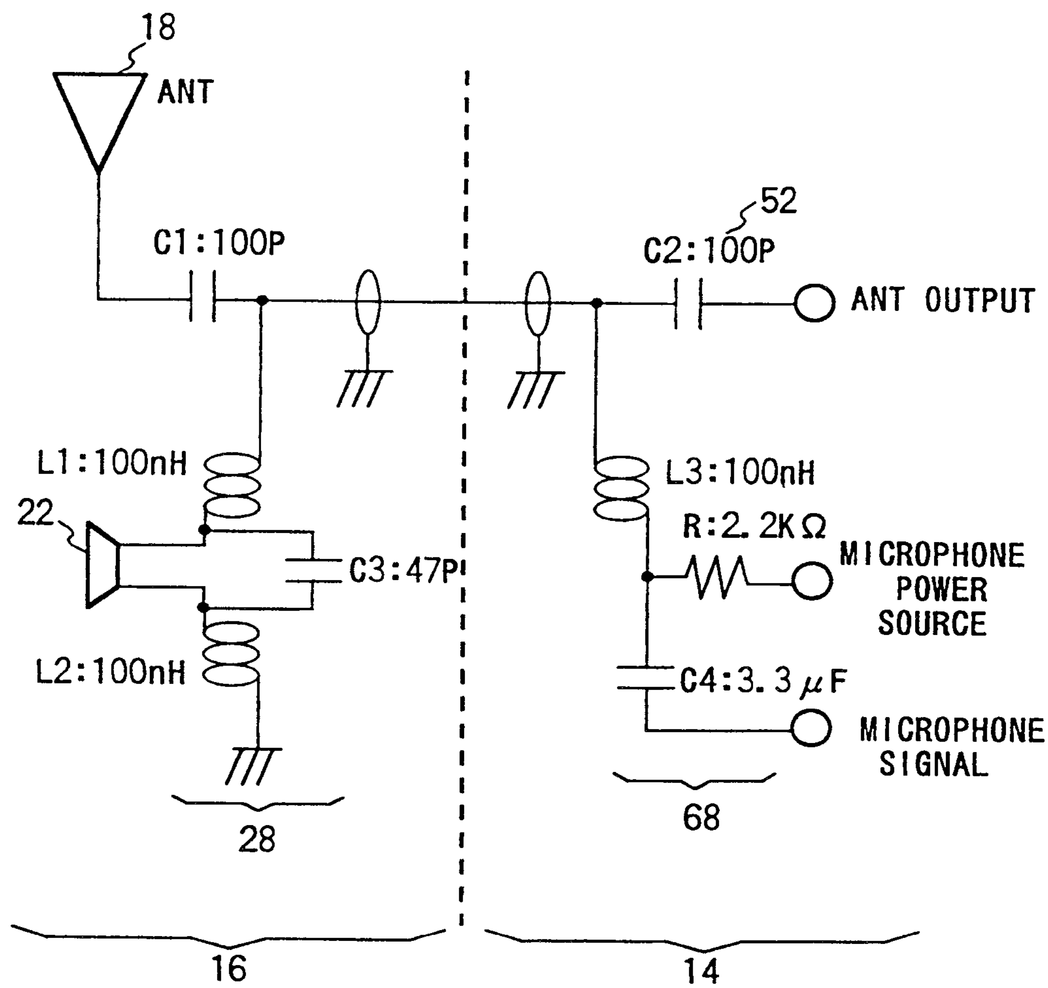

18
ANT
C1:100P
52
C2:100P
ANT OUTPUT
L1:100nH
22
C3:47P
L2:100nH
L3:100nH
R:2.2KΩ
MICROPHONE POWER SOURCE
C4:3.3μF
MICROPHONE SIGNAL
28
68
16
14

FIG. 8

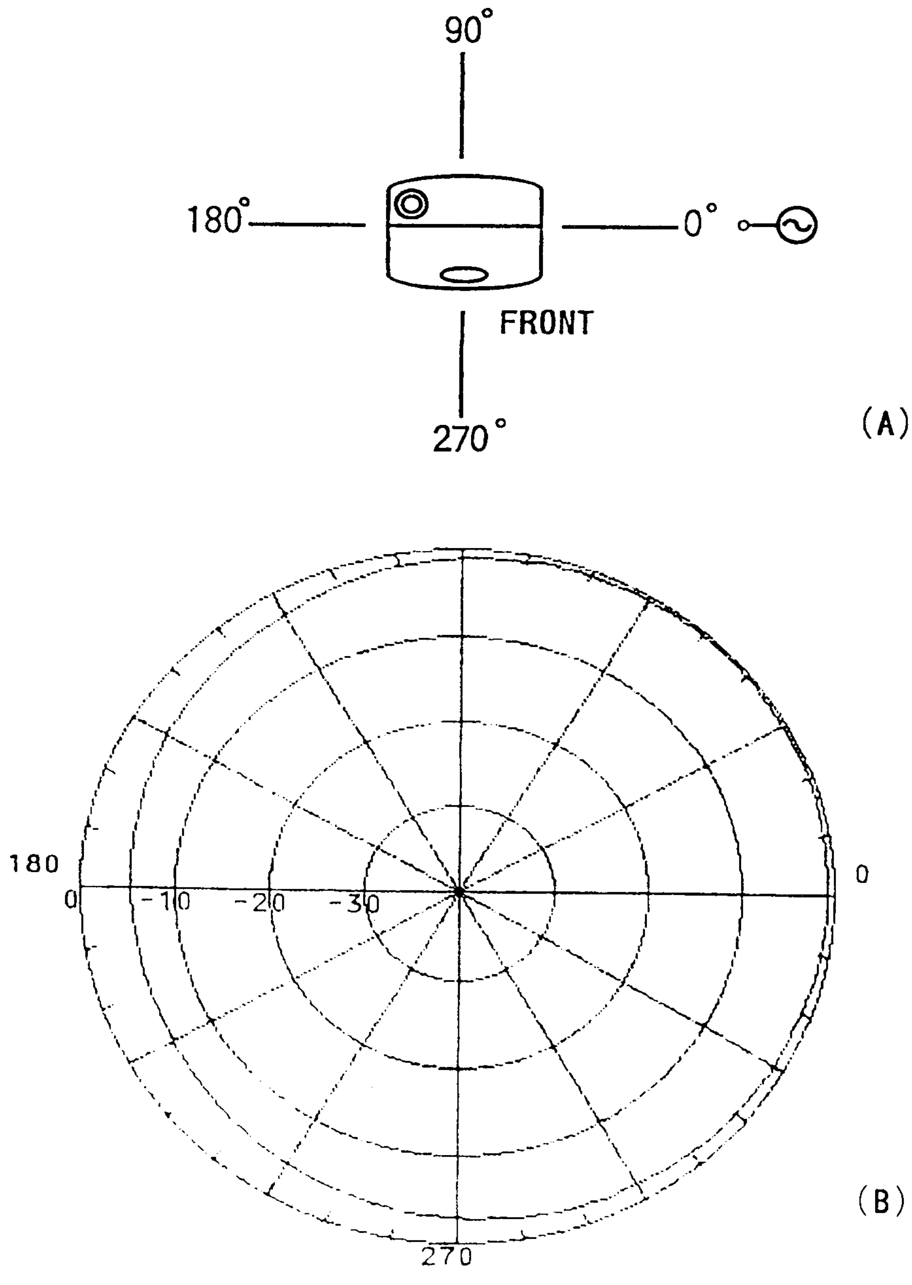
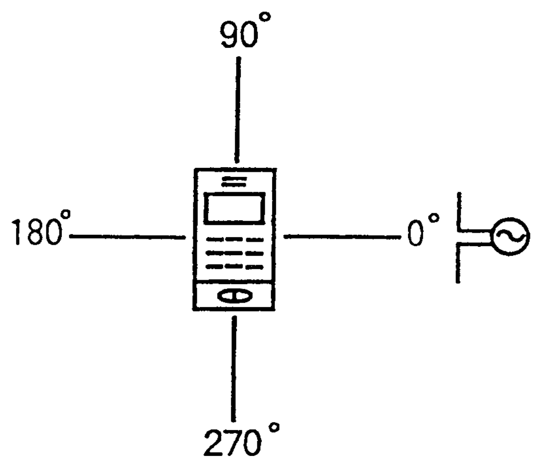
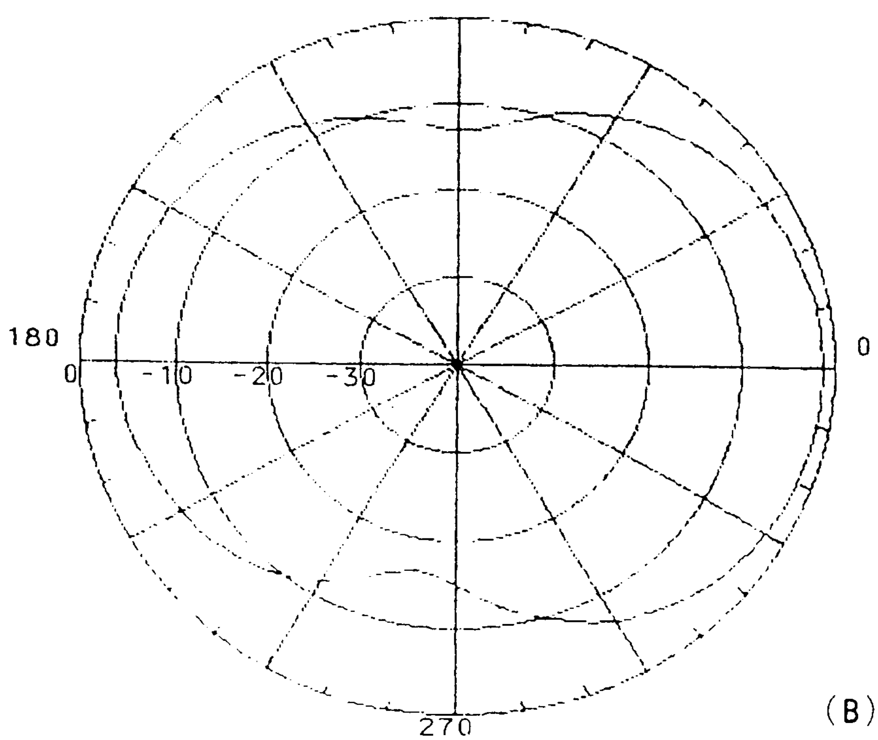


FIG. 9



(A)



(B)

FIG. 10

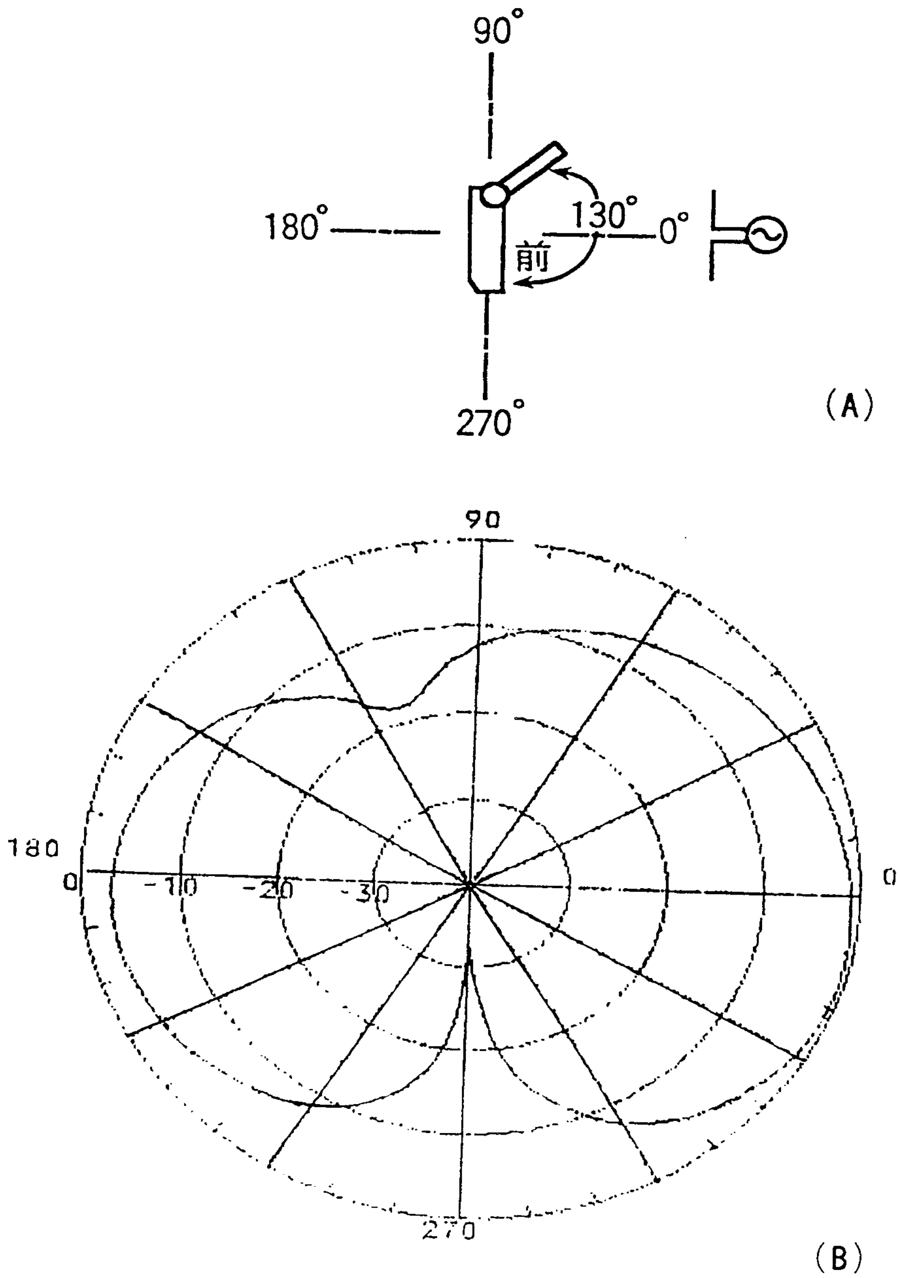


FIG. 11

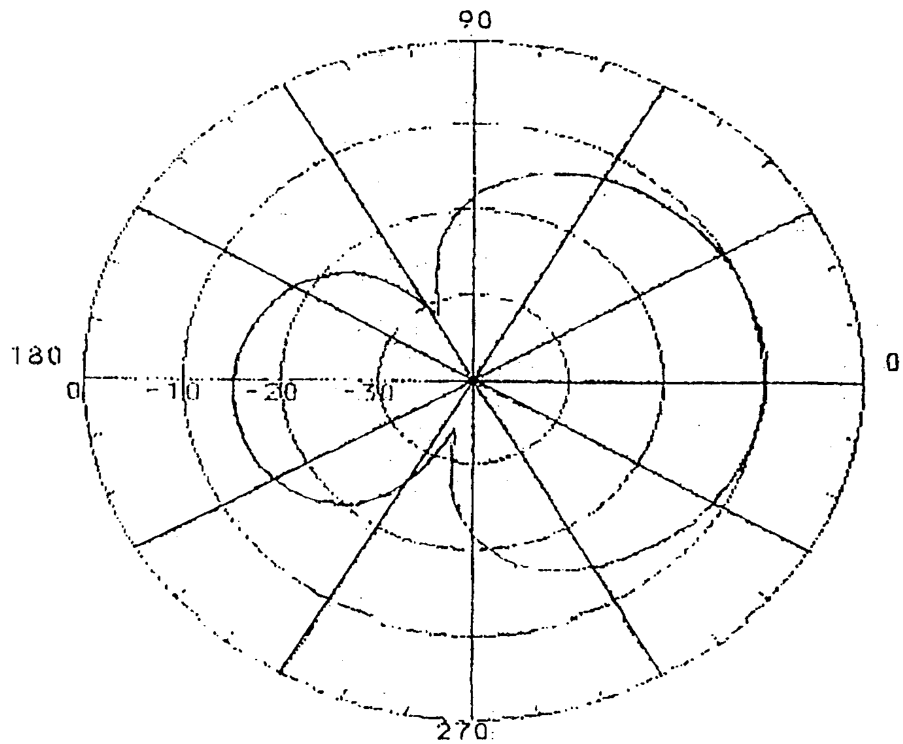


FIG. 12

INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/EP 99/08819

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04B1/38 H01Q1/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04B H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 170 173 A (KRENZ ERIC L ET AL) 8 December 1992 (1992-12-08)	1,3,4, 13,23, 24,26
A	abstract	2,5,6,9, 14,15, 18,19,22
	column 1, line 57 -column 2, line 68 figure 1 figure 2 ---	
X	US 5 649 306 A (DAILEY KIRK W ET AL) 15 July 1997 (1997-07-15)	1,4,18
A	abstract	2,3,5,6, 9,13,19, 22,24
	column 4, line 33 -column 6, line 17 figure 1 figure 5 --- -/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
3 April 2000	10/04/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Lindhardt, U

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INTERNATIONAL SEARCH REPORT

Inte   nal Application No
PCT/EP 99/08819

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 508 567 A (SHAYE COMMUNICATIONS LTD) 14 October 1992 (1992-10-14) the whole document -----	1-13,18, 24-27, 29-31

1

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Information on patent family members

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